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INTERNATIONAL PRELIMINARY EXAMINATION REPORT
(PCT Article 36 and Rule 70)

Applicant's or agent's file reference IONAPA0201WO		FOR FURTHER ACTION See Notification of Transmittal of International Preliminary Examination Report (Form PCT/PEA/416)	
International application No. PCT/DK 03/00367	International filing date (day/month/year) 04.06.2003	Priority date (day/month/year) 04.06.2002	
International Patent Classification (IPC) or both national classification and IPC G02B6/12			
Applicant NKT INTEGRATION AS			
<p>1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.</p> <p>2. This REPORT consists of a total of 7 sheets, including this cover sheet.</p> <p><input checked="" type="checkbox"/> This report is also accompanied by ANNEXES, i.e. sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).</p> <p>These annexes consist of a total of 3 sheets.</p>			
<p>3. This report contains indications relating to the following items:</p> <p>I <input checked="" type="checkbox"/> Basis of the opinion</p> <p>II <input type="checkbox"/> Priority</p> <p>III <input type="checkbox"/> Non-establishment of opinion with regard to novelty, inventive step and industrial applicability</p> <p>IV <input checked="" type="checkbox"/> Lack of unity of invention</p> <p>V <input checked="" type="checkbox"/> Reasoned statement under Rule 66.2(a)(ii) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement</p> <p>VI <input type="checkbox"/> Certain documents cited</p> <p>VII <input type="checkbox"/> Certain defects in the international application</p> <p>VIII <input type="checkbox"/> Certain observations on the international application</p>			
Date of submission of the demand 19.12.2003		Date of completion of this report 18.10.2004	
Name and mailing address of the international preliminary examining authority:  European Patent Office - P.B. 5818 Patentlaan 2 NL-2280 HV Rijswijk - Pays Bas Tel. +31 70 340 - 2040 Tx: 31 651 epo nl Fax: +31 70 340 - 3016		Authorized Officer Verbandt, Y Telephone No. +31 70 340-2939 	

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I. Basis of the report

1. With regard to the **elements** of the international application (*Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17)*):

Description, Pages

1-48 as originally filed

Claims, Numbers

1-33 as originally filed
34-54 received on 21.09.2004 with letter of 21.09.2004

Drawings, Sheets

1/16-16/16 as originally filed

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

These elements were available or furnished to this Authority in the following language: , which is:

- ☐ the language of a translation furnished for the purposes of the international search (under Rule 23.1(b)).
☐ the language of publication of the international application (under Rule 48.3(b)).
☐ the language of a translation furnished for the purposes of international preliminary examination (under Rule 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

- ☐ contained in the international application in written form.
☐ filed together with the international application in computer readable form.
☐ furnished subsequently to this Authority in written form.
☐ furnished subsequently to this Authority in computer readable form.
☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. The amendments have resulted in the cancellation of:

- ☐ the description, pages:
☐ the claims, Nos.:
☐ the drawings, sheets:

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5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)).

(Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.)

6. Additional observations, if necessary:

IV. Lack of unity of invention

1. In response to the invitation to restrict or pay additional fees, the applicant has:

- ☐ restricted the claims.
☐ paid additional fees.
☐ paid additional fees under protest.
☒ neither restricted nor paid additional fees.

2. ☐ This Authority found that the requirement of unity of invention is not complied with and chose, according to Rule 68.1, not to invite the applicant to restrict or pay additional fees.

3. This Authority considers that the requirement of unity of invention in accordance with Rules 13.1, 13.2 and 13.3 is

- ☐ complied with.
☒ not complied with for the following reasons:

see separate sheet

4. Consequently, the following parts of the international application were the subject of international preliminary examination in establishing this report:

- ☐ all parts.
☒ the parts relating to claims Nos. 1-10,41-54 .

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes: Claims	1-10,41-54
	No: Claims	
Inventive step (IS)	Yes: Claims	
	No: Claims	1-10,41-54
Industrial applicability (IA)	Yes: Claims	1-10,41-54
	No: Claims	

2. Citations and explanations

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see separate sheet

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Re Item IV

Lack of unity of invention

This Authority considers that there are 3 inventions covered by the claims indicated as follows:

- I: Claims 1-10,41-54
- II: Claims 11-30
- III: Claims 31-40

The reasons for which the inventions are not so linked as to form a single general inventive concept, as required by Rule 13.1 PCT, are as follows:

The prior art has been identified as document D1 and discloses (reference numerals between brackets refer to this document) an optical branching unit with :

- (a) input and output waveguides (resp. 85 and 86) with cores (26) embedded in a cladding (27,28);
- (b) a branching part (80) with its input width, which is equal to the input waveguide's width, gradually expanding to its output width, which is equal to the sum of the widths of the output waveguides;
- (c) a multitude of transversal waveguide cores (82) which connect the output waveguide cores

With respect to D1 the special technical features (STF) of the different inventions within the meaning of Rule 13.2 PCT are as follows :

- Invention 1 : Splitter has a Y shaped form with diverging output waveguides (claim 2)
- Invention 2 : A stress relieving element is located in the vicinity of the waveguide cores
- Invention 3 : The waveguides are segmented waveguides.

The STF which are identified here are not identical.

In addition, the following problems are solved by the STF of the different inventions :

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- Problem of invention 1 : Reducing the radiation losses in a simple Y-splitter (description p. 11, l. 14-16)
- Problem of invention 2 : Reducing the birefringence of the waveguides (description p. 22, l. 1-6)
- Problem of invention 3 : Ensuring the complete covering of the waveguide cores with cladding material (description p.26, l. 16 -30).

Mutual comparison of the above problems as seen in the light of the description and of the submitted drawings, shows that the STF solve different problems and do not provide a corresponding technical effect. Hence, the STF are also not corresponding.

Consequently, neither the objective problem underlying the subjects of the claimed inventions, nor their solutions defined by the special technical features allow for a relationship to be established between the said inventions, which involves a single general inventive concept.

In conclusion, the groups of claims are not linked by common or corresponding special technical features and define 3 different inventions not linked by a single general inventive concept.

The application, hence does not meet the requirements of unity of invention as defined in Rules 13.1 and 13.2 PCT.

Re Item V

Reasoned statement with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

Reference is made to the following documents:

D1: US-A-5 745 618 (LI YUAN P) 28 April 1998

D2: EP-A-0 731 367 (AT & T CORP) 11 September 1996

The present application do not meet the criteria of Article 33(1) PCT, because the subject-matter of claims 1, 41 and 45 is not inventive in the sense of Article 33(3) PCT.

Document D1 discloses (reference numerals between brackets refer to this document) an optical branching unit with :

- (a) input and output waveguides (resp. 85 and 86) with cores (26) embedded in a

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cladding (27,28);

(b) a branching part (80) with its input width, which is equal to the input waveguide's width, gradually expanding to its output width, which is equal to the sum of the widths of the output waveguides;

(c) a multitude of transversal waveguide cores (82) which connect the output waveguide cores.

From this the subject-matter of claim 1 differs in that the width of the branching part at the output is equal to the sum of the widths of the output waveguide cores. In D1 the width of the branching part is larger than the sum of the widths of the output waveguides. This feature does not solve any particular problem. Hence, the subject-matter of claim 1 is not considered to involve an inventive step.

It could be argued that this feature reduces the insertion losses of the coupler, but D1 clearly states that the disclosed design of the branching part together with the transversal waveguide cores reduces the insertion loss (e.g., D1, col. 3, l. 25).

From the disclosure of D1 the subject-matter of claim 41 differs in that, at the end of the parts of the device where the waveguides run parallel, the waveguides diverge. Again, this is a slight variation in the design of the coupler of D1, which does not solve any particular problem. The skilled person would always design the paths to and from the coupler in such a way that to facilitate the signal routing in the device and its manufacturing, i.e. taking into account the technical parameters of the processes such as masking, etching, ...

The subject-matter of claim 45 does not involve an inventive step, because it specifies a method of manufacturing the component of claims 1 or 41, by means of method steps, which are obvious for the skilled person when faced with the problem of manufacturing the optical branching unit of claims 1 or 41.

Dependent claims 2-10, 42-44, 46-54 do not contain any features which, in combination with the features of any claim to which they refer, meet the requirements of the PCT in respect of novelty and/or inventive step, for the following reasons :

- Claims 5-8, 50-54 : disclosed by D1
- Claims 2-4, 9, 10, 46-49 : obvious for the skilled person
- Claims 42-44 : disclosed by D2

mirror symmetric around an axis midway between the centre axes of the two waveguide sections.

34. An optical component as claimed in claims 31-33 wherein the spacing
5 between each waveguide segment in a direction of intended light transmission of a waveguide section is identical for all segments.

35. An optical component as claimed in claims 32-34 wherein the angle of a
10 parallelogram $90^\circ + \alpha$ defining a waveguide piece as defined by an edge of one waveguide section facing the other waveguide section and the first edge encountered by light propagated in the intended direction of light transmission is larger than 90° .

36. An optical component as claimed in claim 35 wherein the angle α is
15 around 8° .

37. An optical component as claimed in any of claims 31-36 comprising
transversal waveguide core elements between segmented waveguide
20 sections.

38. An optical component as claimed in claim 37 wherein the transversal
waveguide core elements of a waveguide section are angled compared to an
intended direction of light transmission of the waveguide section.

25 39. An optical component as claimed in claim 38 wherein the transversal waveguide elements meet the corresponding waveguide segments at an angle substantially equal to $90-\alpha$.

40. An optical component as claimed in any of claims 37-39 wherein the
30 transversal waveguide elements are segmented.

41. An optical coupler comprising a combination of planar waveguides on a
substrate, each waveguide comprising a core region pattern surrounded by
lower and upper cladding layers, the core region pattern being formed in a
35 layer applied to the lower cladding layer supported by the substrate and the upper cladding layer being applied to cover the core region pattern and the

lower cladding layer, the combination of waveguides comprising a length of at least two spaced waveguide core sections wherein transversal elements are arranged between said spaced waveguide core sections.

- 5 42. An optical coupler as claimed in claim 40 comprising two spaced substantially parallel waveguide sections wherein the cross sections of the two waveguide sections and connecting transversal elements when viewed in a planar cross section are mirror symmetric around an axis midway between the centre axes of the two waveguide sections.
- 10 43. An optical coupler as claimed in claim 42 wherein the transversal waveguide core elements of a waveguide section are angled compared to an intended direction of light transmission of the waveguide section to minimize back-reflections.
- 15 44. An optical coupler as claimed in claim 43 wherein said spaced waveguide core sections are segmented each comprising a number of waveguide core pieces separated by a space filled with upper cladding material.
- 20 45. A method of manufacturing an optical component comprising a combination of planar waveguides on a substrate, the combination of waveguides comprising spaced, parallel, diverging or merging waveguide core sections forming a core region layout in a planar view, the method comprising the steps of
- 25 a) providing a substrate,
- b) forming a lower cladding layer on the substrate,
- c) forming a core layer on the lower cladding layer,
- d) providing a core mask comprising a core pattern corresponding to the core region layout and a layout of transversal elements, the transversal elements
- 30 extending between at least two of said spaced, parallel, diverging or merging waveguide core sections, thereby fully or partially connecting them,
- e) forming core sections and transversal elements using said core mask, a photolithographic and an etching process, and
- f) forming an upper cladding layer to cover the waveguide core sections, the
- 35 transversal elements and the lower cladding layer

wherein at least one of the steps b), c), f) is performed by plasma enhanced chemical vapour deposition.

46. A method as claimed in claim 45 wherein the substrate is a silicon substrate, and the core and cladding layers comprise silica glass.

47. A method as claimed in claim 45 or 46 wherein the upper cladding layer has a lower flow temperature than that of the core and the lower cladding layer.

48. A method as claimed in claim 47 wherein the upper cladding layer comprises boron and/or phosphorus.

49. A method as claimed in any of claims 45-48 wherein all layers on the substrate are formed by plasma enhanced chemical vapour deposition.

50. A method as claimed in any of claims 47-49 wherein step f) comprises successive deposition and annealing steps.

51. A method as claimed in any of claims 45-50 wherein the waveguide core sections that are fully or partially connected by transversal elements form part of a coupler or a splitter.

52. A method as claimed in claim 51 wherein the waveguide core sections that are fully or partially connected by transversal elements run essentially parallel over a certain length of the waveguides.

53. A method as claimed in claim 51 or 52 wherein the waveguide core sections that are fully or partially connected by transversal elements essentially diverge from each other over a certain length of the waveguides.

54. A method as claimed in any of preceding claim wherein at least one of the transversal elements fully connects two waveguide core sections.

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